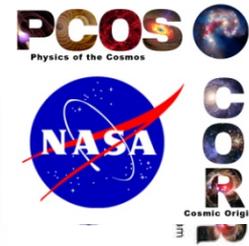


# Demonstration of a TRL 5 Laser System for eLISA

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## Objectives and Key Challenges:

- Develop 1.5W light source for the eLISA gravitational wave mission using a Master Oscillator Power Amplifier design with a novel diode laser oscillator (External Cavity Laser, ECL) followed by a 1.5W Yb fiber amplifier, providing a highly stable, compact, and reliable system
- Test the laser system for reliability, and for amplitude and frequency stability, achieving the required noise performance
- Demonstrate system TRL 5

## Significance of Work:

- Development, with industrial partner (Redfern Integrated Optics), of space qualified, ultra low-noise oscillator
- Demonstration of low-noise power amplifier with servo controls
- Noise and reliability tests of full laser system

## Approach:

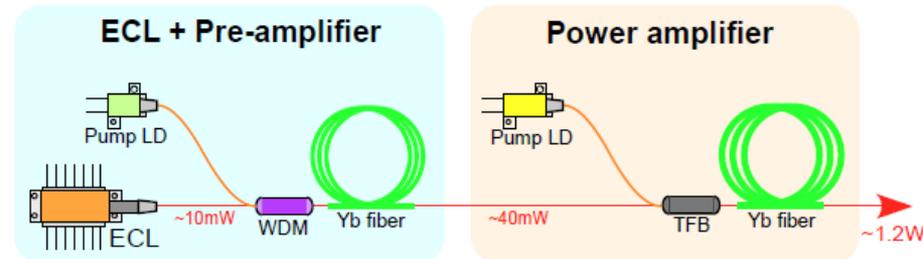
- Noise optimization of 1064 nm External Cavity Laser (RIO)
- Reliability study of External Cavity Laser
- Implementation of amplitude and frequency servo controls on full laser system, achieving  $RIN=10^{-4}$  at  $10^{-3}$  Hz, frequency noise = 300 Hz /  $\text{Hz}^{1/2}$  at  $10^{-2}$  Hz, and differential phase noise =  $6 \times 10^{-4}$  rad/ $\text{Hz}^{1/2}$  at  $10^{-2}$  Hz

## Key Collaborators:

- Kenj Numata, Mike Krainak (NASA/GSFC)
- Low Stolpner (Redfern Integrated Optics)

## Current Funded Period of Performance:

- April 2014 – April 2016



**Master Oscillator / Power Amplifier (MOPA)** configuration of eLISA laser, including ECL, preamp, and diode pumped Ytterbium (Yb) fiber amplifier

## Recent Accomplishments and Next Milestones:

- ✓ Developed and constructed 1.5 W laser amplifier
- ✓ Fabricated world's first butterfly package layout 1064 nm ECL
- Rebuild and test 1.5 W laser amplifier (Aug 2014)
- Preliminary laser system test with NPRO (Dec 2014)
- Noise optimization of ECL optical cavity (Dec 2014)
- Preliminary laser system test with ECL (Mar 2015)
- Noise optimization of ECL gain chip (Jun 2015)
- ECL reliability tests (Aug 2015)
- Full laser system noise testing (Jan 2016)
- Full laser system reliability testing (Mar 2016)

## Applications:

- Laser source for eLISA Gravitational Wave mission
- Oscillator for ground-based GW LIGO project
- Oscillator for GRACE-II mission

$TRL_{In} = 3$   $TRL_{Current} = 3$   $TRL_{Target} = 5$